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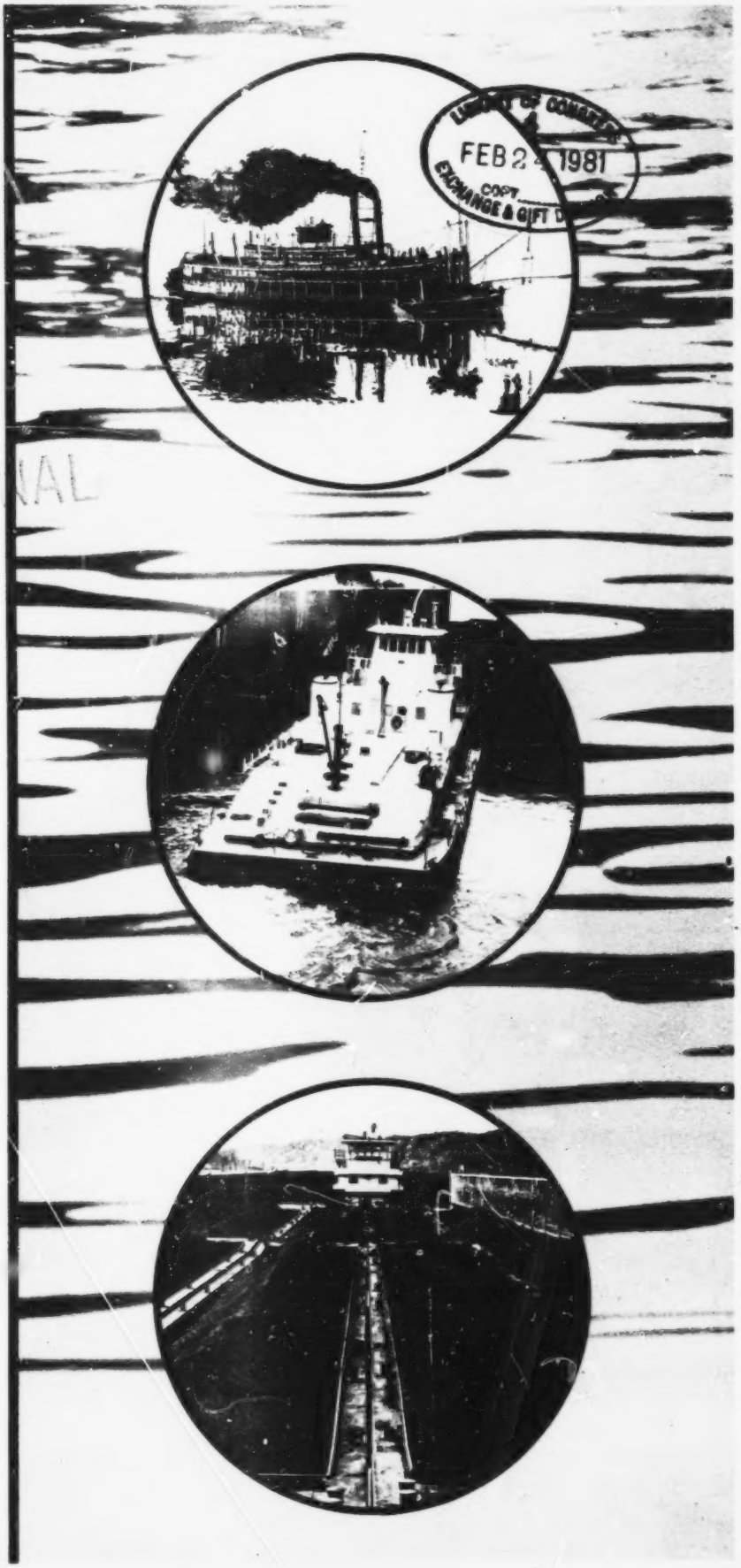
71

Projections Of Demand For Waterborne Transportation

Ohio River Basin
1980 - 2040

Volume 17

Other, Nec.



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projects of future traffic demands for all of the navigable waterways of the Basin. Each report contains information on past and present waterborne commerce in the Basin and projections by commodity groups and origin-destination areas from 1976 to at least 1990.

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(Continued from #20)
The three study projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River and the Tennessee River, as well as other improvements.

This document is volume 17 of the 17 volume report shown below.

The study included a Commodity Resource Inventory, a Modal Split Analysis and a Market Demand Analysis. The work included investigation and analyses of the production, transportation and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of and within the Ohio River Basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A study summary aggregates the commodity group totals for each of the several projections periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin. The study results are presented in the following 17 documents:

Volume	Subject Title	
1	Study summary	
2	Methodology	
3	Group I:	Coal and coke
4	Group II:	Petroleum fuels
5	Group III:	Crude Petrol.
6	Group IV:	Aggregates
7	Group V:	Grains
8	Group VI:	Chemicals and chemical fertilizers
9	Group VII:	Ores and Minerals
10	Group VIII:	Iron ore, steel and iron
11	Group IX:	Feed and food products, nec.
12	Group X:	Wood and paper products
13	Group XI:	Petroleum products, nec.
14	Group XII:	Rubber, plastics, nonmetallic, mineral, products, nec.
15	Group XIII:	Nonferrous, metals and alloys, nec.
16	Group XIV:	Manufactured products, nec.
17	Group XV:	Other, nec.

Additionally, an Executive Summary is available as a separate document.

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Volume 17 of 17

GROUP XV: OTHERS, NEC.

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION OHIO RIVER BASIN 1980, 1990, 2000, 2020, 2040

Prepared for

U.S. ARMY CORPS OF ENGINEERS
OHIO RIVER DIVISION, HUNTINGTON DISTRICT

Contract No. DACW69-78-C-0136

by

Robert R. Nathan Associates, Inc.
Consulting Economists
Washington, D.C.

DECEMBER 1980

III

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PREFACE

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River basin navigation system. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of the navigable waterways of the basin. Each report contains information on past and present waterborne commerce in the basin with projections by commodity group and origin-destination areas from 1976 to either 1990 or 2040.

The three projections, in conjunction with other analytical tools and waterway system information, will be used to evaluate specific waterway improvements required to meet short and long-term navigation needs. The output from these studies will serve as input to Corps inland navigation simulation models to help analyze the performance and requirements for improvements of the Ohio River basin navigation system. These data will be used in current studies relating to improvements of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, and the Tennessee River, as well as for other improvements.

The reports on the three studies are referred to as the "CONSAD," the "BATTELLE," and the "NATHAN" reports. The latter and final report was completed in November 1980. It was prepared for the Corps of Engineers by Robert R. Nathan Associates, Inc., Consulting Economists, Washington D.C. This study encompasses the period 1976-2040, and is by far the most detailed of the three.

The "CONSAD" report, completed in January 1979, was prepared for the Corps by the CONSAD Research Corporation of Pittsburgh, Pennsylvania. The study and the 1976-1990 projected traffic demands discussed in that report were developed by correlating the historic waterborne commodity flows on the Ohio River navigation system, with various indicators of regional and national demands for the commodities. The demand variables which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections serve as national standards and were developed by the Bureau of Economic Analysis of the U.S. Department of Commerce, in conjunction with the Economic Research Service of the Department of Agriculture.

The "BATTELLE" report was completed in June 1979, and was prepared for the Corps by the Battelle Columbus Laboratories, Columbus, Ohio. The study and the 1976-1990 traffic projections discussed in that report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain an estimate from each individual shipper of his future commodity

movements, by specific origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and requested to provide the survey information. In addition, personal interviews were held with the major shippers. The responses were then aggregated to yield projected traffic demands for the Ohio River navigation system.

The "NATHAN" report presents the findings of a commodity resource inventory, a modal split analysis and a market demand analysis. The work included investigation and analyses of the production, transportation, and demand characteristics of each of the major commodities transported on the Ohio River and its tributaries. For each of 15 commodity groups, the demand for waterway transportation into, out of, and within the Ohio River basin was projected through the year 2040. A detailed study analysis and discussion for each commodity group is presented in 15 individually bound reports, supplemented by a methodology report. A Study Summary and an Executive Summary present appropriately abbreviated discussion and findings resulting from these analyses. The Study Summary aggregates the commodity group totals for each of the several projection periods and lists the total waterborne commerce for each of the 72 operational locks and dams in the Ohio River Basin.

The "NATHAN" report, "Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980, 1990, 2000, 2020, 2040" consists of the following volumes:

Subject Title	Number of Pages	Volume Number
Study Summary	220	1
Methodology	118	2
Group I: Coal and Coke	134	3
Group II: Petroleum Fuels	66	4
Group III: Crude Petroleum	42	5
Group IV: Aggregates	64	6
Group V: Grains	131	7
Group VI: Chemicals and Chemical Fertilizers	90	8
Group VII: Ores and Minerals	61	9
Group VIII: Iron Ore, Steel and Iron	104	10
Group IX: Feed and Food Products, Nec.	44	11
Group X: Wood and Paper Products	61	12
Group XI: Petroleum Products, Nec.	38	13
Group XII: Rubber, Plastic, Nonmetallic Mineral Products, Nec.	41	14
Group XIII: Nonferrous Metals and Alloys, Nec.	57	15
Group XIV: Manufactured Products Nec.	35	16
Group XV: Others, Nec.	48	17

Additionally, an Executive Summary is available as a separate document.

RRNA

PROJECTIONS OF DEMAND FOR WATERBORNE TRANSPORTATION OHIO RIVER BASIN 1980, 1990, 2000, 2020, 2040

Group XV: Others, Nec.

Prepared for
U.S. Army Corps of Engineers
Huntington District
Contract No. DACW69-78-C-0136

by
Robert R. Nathan Associates, Inc.
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November 1980

VII

TABLE OF CONTENTS

	page
I. INTRODUCTION	1
A. Description of Commodity Group XV	1
B. Existing Waterway Traffic Flows	2
B-1. Inbound Movements	2
B-2. Outbound Movements	2
B-3. Local Movements	8
C. Summary of Findings	8
II. MARKET DEMAND ANALYSIS	9
A. Market Areas	9
A-1. Primary Study Areas (PSAs)	9
A-2. Secondary Consumption Areas (SCAs)	10
B. Product Uses	10
B-1. Petroleum and Coal Products, Nec	10
B-2. Slags	11
B-3. Waterway Improvement and Government Materials	12
C. Consumption Characteristics	12
C-1. Petroleum and Coal Products, Nec	12
C-2. Slags	12
C-3. Waterborne Improvement Materials	12
D. Existing Aggregate Demand	13
D-1. Petroleum and Coal Products, Nec	13
D-2. Slags	13
D-3. Waterway Improvement Materials	13
E. Forecasting Procedures and Assumptions	13
F. Probable Future Demand	16
III. COMMODITY RESOURCES INVENTORY	19
A. Production Areas	19
B. Production Characteristics	19
B-1. Petroleum and Coal Products, Nec	19
B-2. Slags	20
B-3. Waterway Improvement Materials	20
C. Existing Production Levels	20
D. Forecasting Procedures and Assumptions	21
E. Probable Future Production Levels	21

page

IV. TRANSPORTATION CHARACTERISTICS..... 27
A. Existing and Historical Modal Split..... 27
B. Intermodal Characteristics and Factors Affecting Modal Choice..... 27
B-1. Barge versus Rail Movement..... 27
B-2. Barge versus Truck..... 29
C. Forecasting Procedures and Assumptions..... 29
D. Probable Future Modal Split..... 31
E. Probable Future Waterway Traffic Flows..... 32

V. APPENDIX..... 35

VI. SOURCES AND REFERENCES..... 43

I. INTRODUCTION

Group XV, others, nec., consists of a large number of commodities which are generally insignificant in terms of their waterborne movements. These commodities have few common consumption, production or transportation characteristics.

The areas within the Ohio River Basin (ORB) for which projections of Group XV consumption, production and movements have been made are designated as Primary Study Areas (PSAs). The PSAs for Group XV are those U.S. Department of Commerce Bureau of Economic Analysis Areas (BEAs) and area segments (aggregations of counties within a BEA) which are origins or destinations of Group XV waterborne movements. A map showing Group XV PSAs is presented in the appendix to this report.

In addition to the PSAs, external areas linked to the ORB through waterborne commerce have been identified. Areas (BEAs) outside the ORB which are destinations of waterborne Group XV movements originating in the ORB are designated as Secondary Consumption Areas (SCAs). Areas (BEAs) outside the ORB which are origins of Group XV waterborne movements destined to the ORB are designated as Secondary Production Areas (SPAs).

A. Description of Commodity Group XV

There are 33 individual commodities in Group XV, ranging from raw cotton, live animals, rock and scrap, to U.S. Department of Defense cargo. During the 1969-76 period, 18 of these commodities recorded no waterborne movements in the Ohio River System (ORS). An additional 12 commodities showed either infrequent or declining movements. These 12 commodities do not have defined transportation patterns, and it is not possible to develop a basis for projections of their future waterborne movements. The three remaining commodities, petroleum and coal products, nec., slag, and government

materials (primarily waterway improvement materials), are designated by Waterborne Commerce Statistics Codes 2991, 3312 and 4118, respectively.

B. Existing Waterway Traffic Flows

Waterway improvement materials accounted for the major portion of Group XV shipments. In 1976, 91 percent of total Group XV traffic, and 97 percent of the group's inbound traffic, consisted of waterway improvement materials.

During the 1969-76 period an average of 73 percent of Group XV waterborne shipments were outbound. Local shipments constituted 23.7 percent, and the remaining 3.3 were inbound shipments to the Ohio River Basin (ORB) from outside the ORB.

In terms of tonnages, the total waterborne shipments of Group XV followed an increasing trend, from 2.8 million tons in 1969 to 4.3 million tons in 1976. An exception, a large increase in 1974, was attributable entirely to an increase in government materials movements necessitated by a flood in 1973 (Table 1).

Table 2 presents the BEA-to-BEA waterborne flows of Group XV as reported in 1976.

B-1. Inbound Movements

Petroleum and coal products, nec., (WCSC 2991) constituted the major share of inbound waterborne movements to the ORS in the 1969-73 period. These shipments originated in oil-producing BEA 141 (Beaumount) or were imports shipped via BEA 138 (New Orleans). In 1973-76, slag became the most important commodity of Group XV in terms of inbound waterway movements. Waterway improvement materials show little inbound movement. An exception, in 1975, showed 116 thousand tons shipped to the ORB from the western part of BEA 115 (Paducah).

B-2. Outbound Movements

Outbound waterway movements from the ORB consist almost entirely of waterway improvement and other government materials. The movements of these commodities showed a rapidly increasing trend in the 1969-76 period. Discussions with suppliers and with Corps of Engineers officials reveal that rip-rap limestone comprises almost all waterway improvement and government materials transported in

Table 1. Ohio River System: Waterborne Shipments of Others, Nec. by Commodity Inbound, Outbound, and Local Movements, 1969-76

(Thousands of tons unless otherwise specified)

Commodity and type of movement	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Total[a]	2,801.7	3,360.4	3,092.0	2,802.0	3,585.1	5,149.1	4,729.9	4,319.4	6.4
Inbound	86.0	102.2	134.5	113.3	114.7	106.6	219.4	127.4	5.8
Outbound	1,522.1	2,182.6	2,240.4	2,101.0	2,574.6	3,694.2	3,267.8	3,534.5	12.8
Local	1,193.7	1,075.5	717.1	587.7	895.8	1,348.3	1,242.7	657.5	(8.2)
Oilseeds	--	--	--	3.6	--	--	--	--	--
Inbound	--	--	--	--	--	--	--	--	--
Outbound	--	--	--	3.6	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Tobacco, leaf	--	--	--	0.7	0.7	0.7	0.4	--	--
Inbound	--	--	--	--	--	--	--	--	--
Outbound	--	--	--	0.7	0.7	0.7	0.4	--	--
Local	--	--	--	--	--	--	--	--	--
Hay and fodder	3.1	--	--	--	--	--	--	--	--
Inbound	--	--	--	--	--	--	--	--	--
Outbound	3.1	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Animals and animal products	--	1.2	--	--	--	--	--	--	--
Inbound	--	1.2	--	--	--	--	--	--	--
Outbound	--	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Crude rubber, allied gums	0.8	0.8	--	--	--	--	--	--	--
Inbound	0.8	0.8	--	--	--	--	--	--	--
Outbound	--	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Field crops, nec.	--	--	--	--	--	--	--	42.0	b
Inbound	--	--	--	--	--	--	--	--	--
Outbound	--	--	--	--	--	--	--	42.0	b
Local	--	--	--	--	--	--	--	--	--

(Continued)

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Table 1. (Continued)

Commodity and type of movement	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Phosphate rock	2.6	--	1.3	--	5.2	7.4	30.4	23.4	36.9
Inbound	1.3	--	1.3	--	5.2	7.4	8.2	5.6	23.2
Outbound	1.3	--	--	--	--	--	22.2	17.8	45.3
Local	--	--	--	--	--	--	--	--	--
Natural fertilizer materials	1.4	--	--	--	--	1.1	--	--	--
Inbound	1.4	--	--	--	--	1.1	--	--	--
Outbound	--	--	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Ordnance and accessories	0.2	0.1	--	--	--	--	--	--	--
Inbound	0.1	--	--	--	--	--	--	--	--
Outbound	0.1	0.1	--	--	--	--	--	--	--
Local	--	--	--	--	--	--	--	--	--
Basic textile products	8.7	4.1	2.6	3.7	3.4	4.8	2.6	3.2	(13.3)
Inbound	8.7	4.1	2.6	2.8	3.4	4.0	2.6	3.2	(13.3)
Outbound	--	--	--	--	--	0.4	--	--	--
Local	--	--	--	0.9	--	0.4	--	--	--
Petroleum, coal products, nec.	178.3	219.6	219.1	122.6	112.9	82.9	20.2	34.2	(21.0)
Inbound	61.8	82.8	104.1	79.0	86.8	60.4	13.0	31.2	(9.3)
Outbound	4.5	15.7	16.2	1.3	--	14.4	--	--	--
Local	112.0	121.1	98.8	42.3	26.1	8.1	7.2	3.0	(40.4)
Slag	64.1	11.5	167.1	77.1	75.0	84.6	109.1	225.7	19.7
Inbound	7.1	5.2	--	--	9.2	11.7	78.3	81.9	41.8
Outbound	--	--	--	2.3	7.0	22.6	10.0	26.3	b
Local	57.0	6.3	167.1	74.8	58.8	50.3	20.8	117.5	10.9

(Continued)

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Table 1.(Continued)

Commodity and type of movement	1969	1970	1971	1972	1973	1974	1975	1976	Average annual percentage change, 1969-76
Nonferrous metal scrap	22.0	4.9	12.3	11.5	4.7	1.3	--	56.5	14.4
Inbound	--	--	9.7	9.9	1.6	--	--	1.1	b
Outbound	22.0	--	--	--	--	--	--	5.6	(17.8)
Local	--	4.9	2.6	1.6	3.1	1.3	--	49.8	b
Waste and scrap, nec.	178.3	243.5	185.8	166.7	98.5	42.0	45.3	3.3	(43.4)
Inbound	2.7	3.0	5.0	--	--	--	0.9	2.2	(2.9)
Outbound	62.7	38.2	80.6	81.1	50.9	30.6	19.5	1.1	(43.9)
Local	112.9	202.3	100.2	85.6	47.6	11.4	24.9	--	--
Miscellaneous shipments	0.1	--	--	--	--	1.4	1.7	--	--
Inbound	--	--	--	--	--	0.3	0.6	--	--
Outbound	--	--	--	--	--	0.4	1.1	--	--
Local	0.1	c	--	--	--	0.7	--	--	--
Waterway improvement, government materials	2,342.2	2,875.0	2,503.9	2,416.2	3,284.7	4,923.0	4,520.1	3,931.2	7.7
Inbound	2.2	5.2	11.8	21.6	8.5	21.7	115.8	2.2	--
Outbound	1,428.4	2,128.8	2,143.6	2,012.1	2,516.0	3,625.1	3,214.6	3,441.8	13.4
Local	911.6	741.0	348.5	382.5	760.2	1,276.1	1,189.7	487.2	(8.6)

Note: Individual items may not add to totals due to rounding.
a. Excludes waterborne commodity code no. 101 (raw cotton); 112 (flaxseed); 131 (fresh fruits); 132 (bananas); 133 (coffee); 134 (cocoa beans); 141 (vegetables); 151 (live animals); 191 (miscellaneous farm products); 911 (fresh fish); 912 (shellfish); 913 (menhaden); 4022 (textile scrap); 4024 (paper waste); 4111 (water); 4113 (LCC freight); and 9999 (Department of Defense controlled cargo and special category items) for which no movements were reported.
b. No movements reported in 1969.
c. Less than 50 tons.
Source: Compiled by RRNA from Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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Table 2. Ohio River Basin: Waterborne Commerce by BEA, 1976
Group 15: Others, Nec.

(Thousands of tons)

Origin	Destination										
	Total	ORB BEAs	BEA 47	BEA 49	BEA 52	BEA 54	BEA 55	BEA 62	BEA 64	BEA 66	BEA 115
Total	4,319.4	784.9	2.2	37.8	63.6	1.1	32.2	8.7	88.0	60.6	490.7
ORB BEAs	4,192.0	657.5	--	--	27.3	--	6.7	3.1	79.1	52.8	488.5
BEA 47	1.1	--	--	--	--	--	--	--	--	--	--
BEA 49	21.1	1.1	--	--	--	--	--	--	--	--	1.1
BEA 52	15.6	11.1	--	--	3.3	--	--	--	--	7.8	--
BEA 54	1.1	1.1	--	--	--	--	--	1.1	--	--	--
BEA 55	11.9	3.0	--	--	--	--	--	--	3.0	--	--
BEA 62	42.0	42.0	--	--	--	--	--	--	--	42.0	--
BEA 64	24.0	24.0	--	--	24.0	--	--	--	--	--	--
BEA 66	90.5	82.2	--	--	--	--	--	2.0	67.1	2.0	11.1[a]
BEA 115	3,984.7	493.0	--	--	--	--	6.7	--	9.0	1.0	476.3
Non-ORB BEAs	127.4	127.4	2.2	37.8	36.3	1.1	25.5	5.6	8.9	7.8	2.2
BEA 114	23.4	23.4	--	--	--	--	23.4	--	--	--	--
BEA 117	2.2	2.2	2.2	--	--	--	--	--	--	--	--
BEA 119	2.2	2.2	--	--	--	--	--	--	--	--	2.2
BEA 137	1.1	1.1	--	--	--	--	1.1	--	--	--	--
BEA 138	55.5	55.5	--	37.8	1.1	1.1	1.0	5.6	8.9	--	--
BEA 140	6.7	6.7	--	--	--	--	--	--	--	6.7	--
BEA 141	36.3	36.3	--	--	35.2	--	--	--	--	1.1	--

(Continued)

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Table 2. Continued

Origin	Destination														
	Non-ORB BEAs	BEA 38	BEA 46	BEA 77	BEA 91	BEA 114	BEA 115[b]	BEA 132	BEA 133	BEA 134	BEA 135	BEA 137	BEA 138	BEA 140	BEA 141
Total	3,534.5	5.6	383.5	8.9	11.1	5.6	436.3	444.0	4 ..8	200.3	43.4	13.0	1,543.2	6.7	1.1
ORB BEAs	3,534.5	5.6	383.5	8.9	11.1	5.6	436.3	444.0	431.8	200.3	43.4	13.0	1,543.2	6.7	1.1
BEA 47	1.1	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1
BEA 49	20.0	--	--	--	11.1	--	--	--	--	--	--	--	8.9	--	--
BEA 52	4.5	--	--	--	--	4.5	--	--	--	--	--	--	--	--	--
BEA 54	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 55	8.9	--	--	8.9	--	--	--	--	--	--	--	--	--	--	--
BEA 62	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BEA 66	8.3	--	4.0	--	--	1.1	--	--	--	--	--	--	3.2	--	--
BEA 115	3,491.7	5.6	379.5	--	--	--	436.3	444.0	431.8	200.3	43.4	13.0	1,531.1	6.7	--
Non-ORB BEAs															
BEA 114															
BEA 117															
BEA 119															
BEA 137							**Traffic external to Ohio River System**								
BEA 138															
BEA 140															
BEA 141															

a. Includes 9.0 thousand tons shipped from BEA 66 via BEA 68.
b. Consists of counties external to Ohio River Basin.
Source: U.S. Army Corps of Engineers, Waterborne Commerce by Port Equivalents, revised 1976.

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the Ohio River System. This limestone, used in waterway maintenance and construction, is produced in BEA 115 (Paducah) and is readily accessable to rivers within and outside the ORS.

B-3. Local Movements

Waterborne movements of Group XV within the ORB (local movements) also were dominated by waterway improvement and government materials during 1969-76. The large tonnage movements of these materials tend to exaggerate the importance of Group XV traffic during the period because most movements were from points near the mouths of the Tennessee and Cumberland Rivers to the Mississippi River, a journey of less than 60 miles. If ton miles, rather than the total tonnage, are considered, then the importance of these materials is diminished.

C. Summary of Findings

In the 1969-76 period, the production of the major Group XV commodities in the Primary Study Areas averaged 16 million tons per year. Consumption, however, averaged 5.3 million tons. This resulted in large outbound movements of the commodities by rail, truck and barge. Waterway improvement materials accounted for the largest share of Group XV waterborne shipments.

The production-consumption gap is projected to increase slightly (with fluctuations) in the 1976-2040 period, resulting in an increase in gross waterborne shipments. However, as a result of an increase in inbound shipments of petroleum products, net waterborne movements (outbound minus inbound movements) are projected to decrease at an average annual rate of 0.2 percent per annum between 1976 and 2040. Specifically, outbound shipments are projected to increase from 3.5 million tons in 1976 to a peak of 3.8 million tons in 1990 and are expected to decrease to 3.7 million tons annually by 2040. Local shipments are expected to follow the same trend. Inbound shipments are expected to increase steadily from 127.4 thousand tons in 1976 to 698.4 thousand tons in 2040.

II. MARKET DEMAND ANALYSIS

Consumption of the major Group XV commodities in the PSAs experienced a slightly decreasing trend during the pase decade. While consumption of slag, petroleum and coal products, nec., fluctuated, it did not develop an increasing or decreasing trend, and consumption of waterway improvement and government materials decreased.

A. Market Areas

In addition to local demand for Group XV commodities produced in the PSAs, demand also is generated by Secondary Consumption Areas located outside the ORB. These SCAs are defined as BEAs which are the destinations of waterborne Group XV movements originating in the Ohio River Basin.

A-1. Primary Study Areas (PSAs)

This study has identified nine BEAs and BEA segments in the ORB which either have been or will be the ultimate origins or destinations of waterborne movements of Group XV in the ORS. Appendix Table A-1 presents the BEAs and BEA segments which constitute the PSAs for Group XV commodities, and for which commodity consumption has been analyzed and projected.

Because producers and consumers have relatively easy access to the waterways, virtually all of the counties in BEAs 47 (Huntsville) and 49 (Nashville) are analyzed. The ORS provides waterway access to only the eastern part of BEA 115 (Paducah). Counties in this BEA which are served by the Mississippi River have been excluded. Individual counties in other BEAs have been excluded because of their distance from the waterway.

A-2. Secondary Consumption (SCAs) Areas

Most BEAs outside the Ohio River Basin which are destinations of waterborne shipments from the ORB were not segmented[1], nor was any attempt made to analyze or project consumption in these BEAs.

SCAs are BEAs outside the Ohio River Basin which are destinations of waterborne shipments from the ORB. This study identified 14 BEAs as SCAs, most of which receive waterway improvement materials from BEA 115 (Paducah) in the ORB. BEAs along the lower Mississippi River comprise nearly all the SCAs of Group XV.

The principal SCA is BEA 138 (New Orleans). In 1976, this BEA received 1.5 million tons, or 43.7 percent of outbound waterborne traffic of Group XV. Nearly all of this traffic was waterway improvement materials. BEA 132 (Shreveport) is the second major SCA. It received 44.4 thousand tons of waterway improvement materials. BEA 115 (Paducah) received the third largest share of Group XV outbound shipments.

B. Product Uses

Petorleum products have a variety of industrial and household uses. Coal products, as by-products of coke processing, are used within coke plants and in nearby steel mills. Slags, by-products of iron and steel manufacturing, are used mostly as aggregates in construction. The Corps of Engineers, in constructing and maintaining waterways, is the primary consumer of waterway improvement and government materials.

B-1. Petroleum and Coal Products, Nec.

Miscellaneous petroleum products include all petroleum materials which are derivatives of oil and which are not classified under Commodity Group II (Petroleum Fuels), Group III (Crude Oil), or Group XI (Petroleum Products, Nec.). They are identified as "wax" and "miscellaneous commodity products" as defined in the

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1. The exception is BEA 115, which was divided into two areas, a PSA associated with movements on the Ohio River and a SCA receiving shipments from points on the Mississippi River.

Bureau of Mines Minerals Yearbook.[1] Wax is produced primarily for household use, and miscellaneous petroleum products are used by industry, as miscellaneous feedstocks, as well as by households.

Coal products include mostly "coal chemicals." This term refers to the refined materials recovered from crude liquids released during coal carbonization or in the coking process. Approximately 40 percent of these products is consumed within the coke plants. In the past, many of these products have been treated as industrial waste.[2]

As residual products, coal product supplies are limited; they are usually sold to users located close to the producing plants. The common coal chemicals include coke oven ammonia, coke oven gas, coal tar and crude light oils. Coke oven gas accounts for most (80 percent) of the total consumption of these products. It is purchased by steel mills for heating steel and allied plant furnaces. The use of other coal chemicals is scattered among manufacturers and households.

B-2. Slags

Slags are the nonmetallic fractions of the molten mass developed in the furnaces which are used to smelt iron and steel. Decades ago, slags, which were not commercially utilized, created major disposal problems. Today, nearly all slags produced are used in a variety of ways, depending on whether they are iron or steel slags.

Iron or blast furnace slag is used mostly by the construction industry as aggregate in the construction and maintenance of buildings, highways and airports. Today's demand for blast furnace slag is so high that its use is restricted only by the availability of supply, which in turn is dictated by the quantity of iron produced. Steel slags include three major categories: open hearth slags, basic oxygen slags, and electric furnace slags. The quality of steel slags varies with their chemical composition. The construction industry accounts for the consumption of more than 90 percent of commercial steel slags. The major use of slags is as base material in paving. As in the case of iron slag, steel slags consumption is not expected to grow with the consumption of aggregates because of supply constraints.

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1. U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1976 ed. (Washington, D.C.: GPO, 1979), Table 22.

2. For example, the 1975 edition of Minerals Yearbook reported that 11 coke plants did not recover ammonia as a saleable product.

B-3. Waterway Improvement and Government Materials

The principal commodity of this subgroup is rip-rap limestone. This limestone is crushed according to specifications established by the U.S. Army Corps of Engineers. The commodity is used in the repair of riverbanks and in the building of new waterways.

C. Consumption Characteristics

The consumption characteristics of Commodity Group XV are determined by factors influencing product demand. These vary among the individual commodities in the group.

C-1. Petroleum and Coal Products, Nec.

Since this subgroup consists of a large number of commodities, its consumption characteristics vary widely. Generally, the demand for petroleum products is dependent on levels of income and population. The demand for coal products is expected to correlate with the iron and steel production activities in the ORB. In addition, the demand for both petroleum and coal products is influenced by the prices of the products and the prices of substitutable products.

C-2. Slags

The demand for slags is strongly influenced by the construction industry. Discounting short-run fluctuations in construction activity due to business cycles, the long-term demand for slags is a function of population growth and availability. In recent years, the demand for slag has been so large that its consumption is limited only by the available supply which is a function of iron and steel production.

C-3. Waterborne Improvement Materials

The demand for rip-rap limestone is clearly influenced by the Corps of Engineers' construction and river maintenance expenditures. River floods and other river conditions can also increase the consumption of rip-raps during specific periods of time.

D. Existing Aggregate Demand

Consumption of Group XV fluctuated but did not show an increasing trend during the past decade. In 1976, the total consumption of the commodity group was 5.4 million tons, of which 51 percent was petroleum and coal products, nec., and 39 percent was slags. The remaining 10 percent was waterway improvement materials (Table 3).

D-1. Petroleum and Coal Products, Nec.

Consumption of petroleum and coal products in the PSAs amounted to 2.9 million tons in 1969. Consumption decreased slightly in subsequent years but achieved a peak level of 3.1 million tons in 1973. Consumption was 2,503.3 thousand tons in 1975 and 2.8 million thousand tons in 1976.

D-2. Slags

Between 1969 and 1976, slags consumption followed the fluctuating pattern of petroleum and coal products consumption. The reason was that both of these commodity subgroups were directly or indirectly influenced by the consumption of coal in the PSAs.[1]

D-3. Waterway Improvement Materials

The consumption of waterway improvement materials fluctuated more than any of the three subgroups during 1969-76. It ranged from 283 thousand tons (1971) to one million tons in 1975. As discussed above, the consumption of waterway improvement materials is dependent both on national policies related to waterways development and on the vagaries of nature.

E. Forecasting Procedures and Assumptions

The projections of individual commodities in the slag, coal and petroleum products subgroups are based on projections of iron, steel and coal. The main assumptions are that:

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1. Historical data show that, in the PSAs, the consumption of coal products and slags generally change in the same direction with their productions. The production of coal products is derived directly from coal consumption in the coking process; the production of slags is derived from iron and steel production. Iron and steel production, then, consumes coal as a heating source.

Table 3. Ohio River Basin: Consumption of Others, Nec., by Commodity Types and BEAs or BEA Segments[a], 1969-1976

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	5,780.9	5,155.3	4,521.5	4,975.4	5,770.9	5,862.1	5,170.0	5,373.9
Petro, coal products	2,912.1	2,680.5	2,499.6	2,790.5	3,113.6	3,083.0	2,503.3	2,803.4
Slag, iron and steel	1,956.7	1,767.9	1,738.8	1,822.7	2,057.6	1,988.9	1,666.7	2,000.0
Waterway improvement materials	912.1	706.9	283.1	362.2	599.7	790.2	1,000.0	570.5
BEA 47: Huntsville, AL	135.1	122.4	130.9	128.0	153.4	144.8	129.3	160.5
Petro, coal products	12.1	11.1	11.4	11.7	14.6	17.6	22.3	31.6
Slag, iron and steel	122.4	111.3	110.0	116.3	131.7	127.2	107.0	128.9
Waterway improvement materials	0.6	--	9.5	--	7.1	--	--	--
BEA 49: Nashville, TN	274.3	249.5	248.1	286.4	309.2	305.9	273.7	341.9
Petro, coal products	24.7	22.6	23.3	24.0	30.3	37.2	47.1	67.3
Slag, iron and steel	249.6	226.9	224.5	238.7	273.2	268.7	226.2	274.6
Waterway improvement materials	--	--	0.3	23.7	5.7	--	0.4	--
BEA 52: Huntington, WV	585.1	414.7	413.8	440.5	575.2	463.7	379.5	452.9
Petro, coal products	249.2	239.1	237.3	260.9	284.6	268.9	215.0	253.3
Slag, iron and steel	191.7	172.0	169.5	179.1	201.4	194.5	164.5	199.6
Waterway improvement materials	144.2	3.6	7.0	0.5	89.2	0.3	--	--
BEA 54: Louisville, KY	329.4	229.0	291.0	287.2	304.8	272.4	222.1	274.4
Petro, coal products	21.1	19.3	19.8	20.0	25.0	30.3	38.3	54.0
Slag, iron and steel	213.3	193.9	191.1	198.7	225.2	219.1	183.8	220.4
Waterway improvement materials	95.0	15.8	80.1	68.5	54.6	23.0	--	--
BEA 55: Evansville, IN	185.7	209.6	201.9	339.7	242.7	229.6	302.3	170.2
Petro, coal products	24.4	23.1	23.3	24.8	28.7	30.7	32.0	42.5
Slag, iron and steel	123.9	111.7	110.1	115.2	130.4	126.4	106.0	127.7
Waterway improvement materials	37.4	74.8	68.5	199.7	83.6	72.5	164.3	--
BEA 62: Cincinnati, OH	655.4	612.0	602.2	681.8	722.7	686.3	568.5	679.3
Petro, coal products	315.4	304.5	300.4	329.0	360.8	341.5	281.2	334.1
Slag, iron and steel	339.8	307.5	301.8	315.2	357.4	344.8	287.3	342.8
Waterway improvement materials	0.2	--	--	37.6	4.5	--	--	2.4

(Continued)

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Table 3. (Continued)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
BEA 64: Columbus, OH	110.7	652.3	78.7	64.5	309.5	95.4	91.1	79.1
Petro, coal products	6.0	5.6	5.7	5.9	7.3	8.8	11.1	15.6
Slag, iron and steel	60.9	56.0	55.3	58.4	65.8	63.4	53.1	63.5
Waterway improvement materials	43.8	590.7	17.7	0.2	236.4	23.2	26.9	--
BEA 66: Pittsburgh, PA	3,403.2	2,619.9	2,489.9	2,689.0	3,096.9	3,017.4	2,355.7	2,595.8
Petro, coal products	2,255.3	2,051.7	1,874.8	2,110.5	2,357.7	2,342.4	1,849.2	1,994.8
Slag, iron and steel	615.9	553.2	541.3	564.2	630.9	604.4	504.5	601.0
Waterway improvement materials	532.0	15.0	73.8	14.3	108.3	70.6	2.0	--
BEA 115: Paducah, KY	102.0	45.9	65.0	58.3	56.5	646.6	847.8	619.8
Petro, coal products	3.9	3.5	3.6	3.7	4.6	5.6	7.1	10.2
Slag, iron and steel	39.2	35.4	35.2	36.9	41.6	40.4	34.3	41.5
Waterway improvement materials	58.9	7.0	26.2	17.7	10.3	600.6	806.4	568.1

Note: Petroleum and coal products, nec., consist of wax and miscellaneous petroleum products and coal products. The U.S. consumption of petroleum products and slags are allocated to BEA segments on the basis of population distribution. Consumption of coal products for the ORB as a region is assumed to equal its production. Distribution of coal products to the BEA segments was made based on the tonnage of steel produced in each BEA. Waterway improvements materials consumption is assumed to equal the receipt of the materials via the waterways.

a. Segments defined as counties which are ultimate origins or destination of waterborne movements.

Source: U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, various years; Coal (Group I) Report; population data in computer tapes supplied by U.S. Department of Commerce, Bureau of Economic Analysis; Waterborne Commerce by Port Equivalents, 1969 -76, supplied by U.S. Army Corps of Engineers.

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1. The consumption of coal products in the PSAs as a region will equal their production.

2. The consumption of petroleum products will grow at the same rate as the consumption of Group II (Petroleum Products, nec.).

3. The ratio of slags consumption to production in the PSAs will not differ from the average 1974-76 level. Additional notes concerning forecasting procedures and assumptions are presented in Table 3.

4. Waterway improvement materials consumption will increase slightly at the rate of growth of the Corps of Engineers' expenditures for maintenance and bank stabilization in the ORS.[1] Post-1980 consumption will remain at the 1980 level.

F. Probable Future Demand

The consumption of Group XV products in the PSAs is projected to increase from 5.4 million tons in 1976 to 8.2 million tons in 2040, representing an average annual growth rate of 0.66 percent. Although petroleum products consumption will decline, coal products consumption is expected to increase very rapidly. The result is that petroleum and coal products will be the fastest growing commodities in the group.

BEA 52 (Huntington) will be the fastest growing BEA, while BEA 66 (Pittsburgh) will remain the largest consumption area. In 2040, BEA 66 will account for 51.7 percent of the total consumption in the PSAs.

The projected consumption of Group XV, by commodity, is presented in Table 4.

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1. Adjusted for an average of 9 percent inflation rate per annum for the 1976-80 period. New construction use of rip-rap limestone, such as for the construction of the Tennessee-Tombigbee Waterway, is not included.

Table 4. Ohio River Basin: Consumption of Others, Nec., by BEA or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	5,373.9	5,922.4	6,051.5	6,557.3	7,615.9	8,169.5	0.85	0.66
Petro, coal products	2,803.4	3,245.8	3,579.4	3,946.5	4,594.5	4,847.6	1.76	0.86
Slag, iron and steel	2,000.0	2,064.9	1,860.4	1,999.1	2,409.7	2,710.2	(0.52)	0.48
Waterway improvement materials	570.5	611.7	611.7	611.7	611.7	611.7	0.50	0.11
BEA 47: Huntsville, AL	160.5	165.5	170.0	183.3	200.9	206.7	0.41	0.40
Petro, coal products	31.6	32.4	50.0	54.4	45.5	32.0	3.33	0.02
Slag, iron and steel	128.9	133.1	120.0	128.9	155.4	174.7	(0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	341.9	357.8	373.2	402.6	438.0	447.5	0.63	0.42
Petro, coal products	67.3	74.3	117.8	128.1	107.2	75.4	4.08	0.18
Slag, iron and steel	274.6	283.5	255.4	274.5	330.8	372.1	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV	452.9	501.2	504.4	568.2	714.7	804.4	0.77	0.90
Petro, coal products	253.3	295.2	318.8	368.8	474.3	534.1	1.66	1.17
Slag, iron and steel	199.6	206.0	185.6	199.4	240.4	270.3	(0.52)	0.47
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 54: Louisville, KY	274.4	277.6	281.9	303.9	335.4	347.9	0.19	0.37
Petro, coal products	54.0	50.0	76.8	83.5	69.8	49.1	2.55	(0.15)
Slag, iron and steel	220.4	227.6	205.1	220.4	265.6	298.8	(0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 55: Evansville, IN	170.2	193.5	206.8	226.1	250.1	257.2	1.40	0.65
Petro, coal products	42.5	61.6	88.0	98.5	96.3	84.2	5.34	1.07
Slag, iron and steel	127.7	131.9	118.8	127.6	153.8	173.0	(-0.51)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--

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Table 4. (Continued)

BEA and BEA segment	Estimated 1976	Projected 1980	1990	2000	2020	2040	Average annual percentage change 1976-90	1976-2040
BEA 62: Cincinnati, OH	679.3	754.8	794.4	874.7	1,027.1	1,104.1	1.12	0.76
Petro, coal products	334.1	398.2	472.9	529.4	611.4	636.9	2.51	1.01
Slag, iron and steel	342.8	354.0	318.9	342.7	413.1	464.6	(0.51)	0.48
Waterway improvement materials	2.4	2.6	2.6	2.6	2.6	2.6	0.57	0.13
BEA 64: Columbus, OH	79.1	81.6	83.2	89.7	98.5	101.5	0.36	0.39
Petro, coal products	15.6	16.1	24.2	26.3	22.0	15.5	3.19	(0.01)
Slag, iron and steel	63.5	65.5	59.0	63.4	76.5	86.0	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 66: Pittsburgh, PA	2,595.8	2,929.5	2,976.9	3,244.2	3,880.3	4,226.6	0.98	0.76
Petro, coal products	1,994.8	2,309.0	2,417.9	2,643.4	3,156.2	3,412.1	1.38	0.84
Slag, iron and steel	601.0	620.5	559.0	600.8	724.1	814.5	(0.52)	0.48
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 115: Paducah, KY	619.8	660.9	660.7	664.6	670.9	673.6	0.46	0.13
Perto, coal products	10.2	9.0	13.0	14.1	11.8	8.3	1.75	(0.32)
Slag, iron and steel	41.5	42.8	38.6	41.4	50.0	56.2	(0.52)	0.47
Waterway improvement materials	568.1	609.1	609.1	609.1	609.1	609.1	0.50	0.11

Note: Petroleum products consumption for each BEA segment was projected based on the growth rates of consumption of Group XI (Petroleum Products, Nec.) Consumption of coal products for the ORB as a region is assumed to equal production. Distribution of ORB consumption to the BEA segments was made based on the projected steel production by BEAs. The consumption of waterway improvement materials for 1980 was projected based on the rate of growth of the COE budget on river maintenance and bank stabilization by river, deflated 9 percent per year to discount inflation. Consumption of waterway improvement materials in the post 1980 years is assumed to remain at the 1980 level.

a. BEA segment defined as counties which are ultimate origins or destinations of waterborne commerce movements.

Source: Petroleum Products, Nec., (Group XI) and Iron Ore, Steel and Iron (Group VIII) Reports. The COE proposed budget on river maintenance and bank stabilization, and the Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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III. COMMODITY RESOURCES INVENTORY

In the 1969-76 period, the production of the major Group XV commodities in the PSAs averaged 16 million tons. A low of 14.2 million tons was seen in 1971; a high of 19 million tons, in 1974. Production in the PSAs is projected to increase slowly, at an average annual rate of 0.48 percent between 1976 and 2040.

A. Production Areas

The production of Group XV commodities in the PSAs is supplemented by production in Secondary Production Areas located outside the Ohio River Basin. These SPAs are defined as BEAs which are the origins of Group XV waterborne movements destined to the Ohio River Basin.

The largest SPA in 1976 was BEA 114 (St. Louis) which shipped 167 thousand tons to the PSAs and contributed 10 percent of total Group XV consumption in the PSAs. All other SPAs, combined, provided only one thousand tons to the ORB via the waterway in 1976.

B. Production Characteristics

Petroleum and coal products production is dependent on the refining and processing of crude oil and on the consumption of coal in coke plants. Slag production is dependent on the production of iron and steel. The production of waterway improvement materials depends totally on their consumption.

B-1. Petroleum and Coal Products, Nec.

Petroleum products consist of wax and miscellaneous products. These are minor products produced in the refining of crude oil. In 1974-76, a thousand tons of refined crude provided an average of

1.3 tons of wax and 9 tons of miscellaneous products.[1] Wax and miscellaneous petroleums are only by-products; consequently, the selling prices of these products do not significantly influence their production.

Similarly, coal products are chemicals derived in the coking process. The production of these products is almost solely determined by the amount of coke produced. Yields of coal products vary with the kinds of coals which are carbonized, carbonizing temperatures and operating techniques. On the average, about 315 pounds of coke oven gas, 20 pounds of light crude oil and 5 pounds of ammonia are recovered for each ton of coal that is carbonized.[2] After deducting the coal products used in the producing plants themselves, or which are discarded because there is no economic means of marketing them, a ton of carbonized coal yields 0.123 tons of coal products which require transportation.

B-2. Slags

Production of iron and steel causes a formation of nonmetallic fractions of molten mass which must be removed from the furnaces. There are two principal kinds of ferrous slags: iron, or blast furnace slag; and steel, or open-hearth slag. Slag production in blast furnaces ranges from 500 to 750 pounds per ton of pig iron. Steel slag is produced in the three types of steel smelting furnaces: open-hearth, basic oxygen, and electric. A ton of steel production in the open-hearth or basic oxygen process produces 200 to 300 pounds of slag, and production of slag in an electric furnace averages from 100 to 200 pounds per ton of steel produced.

B-3. Waterway Improvement Materials

Waterway improvement materials are used only to maintain or construct the waterways. They are purchased only by the U.S. Army Corps of Engineers on special order; therefore, production depends on the Corps of Engineers' expenditures on these materials.

C. Existing Production Levels

The production of Group XV commodities in the PSAs fluctuated in the 1969-76 period. It averaged three times the tonnage consumed in the PSAs each year.

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1. U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1976 ed. (Washington, D.C.: GPO, 1979).
2. Ibid., p. 504.

The production of all three subgroups of Group XV -- petroleum and coal products, slags, and waterway improvement materials -- fluctuated and showed no definite increasing or decreasing trend. In 1976, 15.3 million tons of Group XV products were produced in the PSAs. Petroleum and coal products accounted for 14.4 percent; slags, 61.7 percent; and waterway improvement materials, 23.9 percent. BEA 66 (Pittsburgh) produced three-quarters of the petroleum and coal products and nearly 80 percent of slags. BEA 114 (Paducah), on the other hand, accounted for almost all of the waterway improvement materials produced in the PSAs (Table 5).

D. Forecasting Procedures and Assumptions

The production of Group XV commodities was projected on the assumption that the production characteristics of these commodities will not differ substantially in the future from those in the past. The growth rates of petroleum products, nec., were estimated on the basis of the projected growth of crude oil consumption in the BEAs. Coal product production was projected on the basis of projected growth and distribution of coal consumed in coking plants. The production of slags was projected at the same rates as iron and steel production by furnace type in each BEA. The growth rates of coal consumed in coking plants, crude oil consumption and iron and steel production are available in reports for Commodity Groups I, III and VIII, respectively.

E. Probable Future Production Levels

The production of Group XV commodities in the PSAs is projected to increase at an average rate of slightly less than one-half percent per year between 1976 and 2040. This growth is mostly attributable to the projected growth of slag production. Following the trend of crude oil consumption, petroleum products production in 2040 will be less than three-fifths the 1976 level. However, the increasing production of coal chemicals raises the growth rate of the petroleum and coal products as a group to 0.25 percent per year in the 1976-2040 period. As in the past, BEA 66 will continue to be a leading producing area of petroleum, coal products and slags, while BEA 115 will remain the principal producing area of waterway improvement materials (Table 6).

Table 5. Ohio River Basin: Production of Others, Nec., by Commodity Types and BEAs or BEA Segments[a], 1969-76

(Thousands of tons)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
Primary Study Areas	16,041.4	15,493.6	14,190.2	15,362.0	17,698.1	19,001.5	15,471.6	15,273.5
Petro, coal products	2,602.8	2,406.6	2,230.1	2,397.5	2,637.6	2,632.7	2,269.0	2,198.6
Slag, iron and steel	11,100.5	10,220.6	9,479.6	10,576.6	11,789.5	11,472.2	8,802.4	9,424.9
Waterway improvement materials	2,338.1	2,866.4	2,480.5	2,387.9	3,271.0	4,896.6	4,400.2	3,650.0
BEA 47: Huntsville, AL	--	--	0.6	--	0.1	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	0.6	--	0.1	--	--	--
BEA 49: Nashville, TN	1.7	2.1	3.9	1.2	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	1.7	2.1	3.9	1.2	--	--	--	--
BEA 52: Huntington, WV	1,413.7	1,362.6	1,346.3	1,371.5	1,615.0	1,484.6	1,139.2	1,295.5
Petro, coal products	311.2	299.3	298.1	289.6	337.1	328.5	274.7	318.9
Slag, iron and steel	1,100.6	1,059.0	1,048.2	1,081.9	1,252.0	1,155.8	864.4	976.6
Waterway improvement materials	1.9	4.3	--	--	25.9	0.3	0.1	--
BEA 54: Louisville, KY	151.7	215.9	157.3	236.5	324.2	170.8	173.0	16.6
Petro, coal products	8.1	7.4	7.7	7.4	8.3	9.8	12.4	16.0
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	143.6	208.5	149.6	229.1	315.9	161.0	160.6	0.6
BEA 55: Evansville, IN	49.0	87.6	91.8	124.2	73.7	36.0	17.2	22.5
Petro, coal products	5.7	3.7	3.7	3.8	4.7	5.8	8.1	12.2
Slag, iron and steel	11.4	11.2	11.1	12.3	13.3	12.2	9.1	10.3
Waterway improvement materials	31.9	72.7	77.0	108.1	55.7	18.0	--	--
BEA 62: Cincinnati, OH	1,844.8	1,580.1	1,364.0	1,467.6	1,668.3	1,458.0	1,096.9	1,237.5
Petro, coal products	268.4	256.8	252.1	270.0	287.2	273.5	212.5	238.3
Slag, iron and steel	1,125.8	1,087.2	1,074.3	1,187.2	1,282.2	1,183.0	884.4	999.2
Waterway improvement materials	450.6	236.1	37.6	10.4	98.9	1.5	--	--

(Continued)

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Table 5. (Continued)

BEA and BEA segment	1969	1970	1971	1972	1973	1974	1975	1976
BEA 64: Columbus, OH	13.7	149.9	1.5	2.1	77.9	20.5	20.6	2.9
Petro, coal products	1.7	1.4	1.5	1.5	1.3	1.8	2.1	2.9
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	12.0	148.5	--	0.6	76.6	18.7	18.5	--
BEA 66: Pittsburgh, PA	11,079.8	9,958.9	9,051.9	10,128.4	11,281.9	11,144.9	8,817.1	9,053.9
Petro, coal products	2,007.7	1,838.0	1,667.0	1,825.2	1,999.0	2,013.3	1,759.2	1,610.3
Slag, iron and steel	8,862.7	8,063.2	7,346.0	8,295.2	9,242.0	9,121.2	7,044.5	7,438.8
Waterway improvement materials	209.4	57.7	38.9	8.0	40.9	10.4	13.4	4.8
BEA 115: Paducah, KY	1,487.0	2,136.5	2,172.9	2,030.5	2,657.0	4,686.7	4,207.6	3,644.6
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	1,487.0	2,136.5	2,172.9	2,030.5	2,657.0	4,686.7	4,207.6	3,644.6

Note: Petroleum and coal products, nec., consist of petroleum products and coal products. Petroleum products include wax and miscellaneous petroleum products, and coal products include coke oven gas, tar, crude light oil and coke oven ammonia. Slags include iron slags and steel slags. Waterway improvement materials primarily include rip-rap limestone produced to meet the specific needs of the U.S. Army Corps of Engineers.

Production of petroleum products, nec., was computed by multiplying the average tons of petroleum products produced per ton of crude oil consumed in the U.S. by the estimated crude oil consumption in the BEAs provided in Commodity Group III Report (Crude Petroleum). Production of coal products was computed from the coal consumed in coke plants in the BEAs, based on the estimates that a ton of coal consumed would yield 0.123 ton of coal products which are not consumed in the producing plants themselves.

Production of iron slags was estimated by applying a factor of 0.3125 tons of slag produced in blast furnaces per ton of pig iron produced to the RRNA estimates of pig iron production by BEA provided in Commodity Group VIII report (Iron ore, Iron and Steel). Production of steel slags is computed by applying the ratios of 250 lbs. of slag per ton of steel produced by open hearth and basic oxygen furnances, and 150 lbs. of slag per ton of steel produced by electric arc furnaces to the BEA's iron and steel production estimates in Group VIII report.

Production of waterway improvement materials was estimated assuming all waterway improvement materials are shipped by barges, i.e. the origin shipments of a BEA equal the total waterway improvement materials produced in that BEA for any particular years.

a. Segments defined as counties which are ultimate origins or destinations of waterway improvements.

Source: Drake, H.J. and J.E. Shelton, "Disposal of Iron and Steel Slag," Proceedings of the Fourth Mineral Waste Utilization Symposium, Chicago, IL., May 1974; U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1975 ed., pp. 505-07; Coal, Crude Petroleum and Iron Ore, Iron and Steel Reports; and Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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Table 6. Ohio River Basin: Production of Others, Nec., by Commodity Types and BEAs or BEA Segments[a], Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976-2040
Primary Study Areas	15,273.5	17,061.7	15,425.4	16,253.8	18,661.7	20,685.4	0.07	0.48
Petro, coal products	2,198.6	2,333.6	1,795.2	1,878.1	2,131.7	2,577.2	(1.44)	0.25
Slag, iron and steel	9,424.9	10,865.4	9,767.5	10,513.0	12,667.3	14,245.5	0.26	0.65
Waterway improvement materials	3,650.0	3,862.7	3,862.7	3,862.7	3,862.7	3,862.7	0.41	0.09
BEA 47: Huntsville, AL	--	--	--	--	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 49: Nashville, TN	--	--	--	--	--	--	--	--
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 52: Huntington, WV.	1,295.5	1,554.4	1,701.7	1,934.9	2,506.5	2,913.5	1.97	1.27
Petro, coal products	318.9	365.0	379.2	405.8	464.0	542.6	1.24	0.83
Slag, iron and steel	976.6	1,189.4	1,322.5	1,529.1	2,042.5	2,370.9	2.19	1.40
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 54: Louisville, KY	16.6	19.3	27.3	25.6	19.7	11.7	3.62	(0.55)
Petro, coal products	16.0	18.7	26.7	25.0	19.1	11.1	3.73	(0.57)
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	0.6	0.6	0.6	0.6	0.6	0.6	0.00	0.00
BEA 55: Evansville, IN	22.5	25.2	33.8	36.7	42.4	43.5	2.95	1.04
Petro, coal products	12.2	12.3	17.4	16.2	12.5	7.3	2.57	(0.80)
Slag, iron and steel	10.3	12.9	16.4	20.5	29.9	36.2	3.38	1.98
Waterway improvement materials	--	--	--	--	--	--	--	--

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Table 6. (Continued)

BEA and BEA segment	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-90	1976 -2040
BEA 62: Cincinnati, OH	1,237.5	1,408.8	1,167.4	1,298.7	1,666.0	1,915.4	(0.42)	0.68
Petro, coal products	238.3	225.5	191.3	201.9	240.9	290.5	(1.56)	0.31
Slag, iron and steel	999.2	1,183.3	976.1	1,096.8	1,425.1	1,624.9	(0.17)	0.76
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 64: Columbus, OH	2.9	6.0	2.0	1.9	1.5	0.9	(2.62)	(1.81)
Petro, coal products	2.9	6.0	2.0	1.9	1.5	0.9	(2.62)	(1.81)
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	--	--	--	--	--	--	--	--
BEA 66: Pitsburgh, PA	9,053.9	10,191.1	8,636.3	9,099.1	10,568.7	11,943.5	(0.34)	0.43
Petro, coal products	1,610.3	1,706.1	1,178.6	1,227.3	1,393.7	1,724.8	(2.20)	0.11
Slag, iron and steel	7,438.8	8,479.8	7,452.5	7,866.6	9,169.8	10,213.5	0.01	0.50
Waterway improvement materials	4.8	5.2	5.2	5.2	5.2	5.2	0.57	0.13
BEA 115: Paducah, KY	3,644.6	3,856.9	3,856.9	3,856.9	3,856.9	3,856.9	0.41	0.09
Petro, coal products	--	--	--	--	--	--	--	--
Slag, iron and steel	--	--	--	--	--	--	--	--
Waterway improvement materials	3,644.6	3,856.9	3,856.9	3,856.9	3,856.9	3,856.9	0.41	0.09

Note: Petroleum and coal products, nec.. consist of petroleum products and coal products. Petroleum products include wax and miscellaneous petroleum products, and coal products include coke oven gas, tar, crude light oil and coke oven ammonia. Slags include iron slags and steel slags. Waterway improvement materials primarily include rip-rap limestone produced to meet specific COE needs.

Production of petroleum products, nec., was projected by multiplying the average tons of petroleum products produced per ton of crude oil consumed in the U.S. in 1974-76 by the projected crude oil consumption in the BEAs provided in Commodity Group III Report (Crude Petroleum). Production of coal products was computed from the projected coal consumed in coke plants in the BEAs, based on the estimates that a ton of coal consumed would yield 0.123 ton of coal products which are not consumed in the producing plants themselves.

Production of iron slag was projected by applying a factor of 0.3125 tons of slag produced in blast furnaces per ton of pig iron produced to the RRNA projection of pig iron production by BEA, provided in Commodity Group VIII Report (Iron Ore, Iron and Steel). Production of steel slags is computed by applying the ratios of 250 lbs. of slag per tons of steel produced by open hearth and basic oxygen furnaces, and 150 lbs. of slag per ton of steel produced by electric arc furnace to the BEAs' iron and steel production projected in Group VIII report.

Production of waterway improvement materials in 1980 was projected base on the weighted average of growth rates of consumption in appropriate river and BEA destination. Production is later years was assumed to approximate the 1980 level.

a. Segments defined as counties which are ultimate origins or destinations of waterborne movements.

Source: Table 3; Drake, H.J. and J.E. Shelton, "Disposal of Iron and Steel Slag", Proceedings of the Fourth Mineral Waste Utilization Symposium, Chicago, IL, May 1974; U.S. Department of the Interior, Bureau of Mines, Minerals Yearbook, 1975 ed., pp. 505-07; Coal (Group I), Crude Petroleum (Group III), and Iron Ore, Steel and Iron (Group VIII) Reports; and Waterborne Commerce by Port Equivalents, 1969-76, supplied by the U.S. Army Corps of Engineers.

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IV. TRANSPORTATION CHARACTERISTICS

Approximately one-third of the transportation of Group XV products in the area served by the ORS is by water. This is a relatively large proportion compared to other products and commodities. The reasons are that these products have relatively low value to weight ratios; they are not easily damaged; and they are usually not required to reach destination points in a short time.

A. Existing and Historical Modal Split

Because Group XV is a widely diversified commodity group, there are often movements in opposite directions. For example, BEA 115 (Paducah) is an originating BEA of waterway improvement materials. However, it also receives petroleum, coal products and slags from the Evansville (BEA 55) and Pittsburgh (BEA 66) areas by truck and waterway. It is difficult, therefore, to generalize about the patterns of modal split or the distribution of Group XV as a whole. Generally, truck movements are most significant for transportation of products to BEAs 49 (Nashville) and 54 (Louisville), and waterborne movements account for most of the outbound shipments from BEA 115 (Paducah). Rail movements of Group XV products are insignificant (Table 7).

B. Intermodal Characteristics and Factors Affecting Modal Choice

The location of production and consumption points for Group XV has made barge transportation a very economical mode, especially for longs hauls. Trucks are used for short-distance movements.

B-1. Barge versus Rail Movement

Discussions with shippers indicate that barges usually have a comparative advantage over rail in the transportation of Group XV

Table 7. Ohio River Basin: Production, of Consumption, and Shipment by Mode of Transportation of Others, Nec., by BEAs or BEA Segments[a], Estimated 1976

(Thousand of tons)

BEA and BEA segment	Production	Consumption	Shipments (receipts)						
			Total net	Water				Net rail	Net truck
				Net	Inbound	Outbound	Local		
Primary Study Areas	15,273.5	5,373.9	9,899.6	3,407.1	127.4[b]	3,534.5[b]	657.5[b]	231.6	260.9
BEA 47: Huntsville, AL	--	160.5	(160.5)	(1.1)	2.2	1.1	--	0.3	(159.7)
BEA 49: Nashville, TN	--	341.9	(341.9)	(16.7)	37.8	21.1	--	4.0	(329.2)
BEA 52: Hungtington, WV	1,295.5	452.9	842.6	(48.0)	60.3	12.3	3.3	104.4	786.2
BEA 54: Louisville, KY	16.6	274.4	(257.8)	--	1.1	1.1	--	--	(257.8)
BEA 55: Evansville, IN	22.5	170.2	(147.7)	(20.3)	32.2	11.9	--	--	(127.4)
BEA 62: Cincinnati, OH	1,237.5	679.3	558.2	33.3	8.7	42.0	--	211.7	313.2
BEA 64: Columbus, OH	2.9	79.1	(76.2)	(64.0)	88.0	24.0	--	33.2	(45.4)
BEA 66: Pittsburgh, PA	9,053.9	2,595.8	6,458.1	29.9	58.6	88.5[c]	2.0	(122.0)	6550.2
BEA 115: Paducah, KY	3,644.6	619.8	3,024.8	3,494.0	14.4	3,508.4	476.3	--	(469.2)

Note: Gross and net waterborne and rail shipments (receipts) were determined for 1976 from U.S. Corps of Engineers waterborne commerce data and Interstate Commerce Commission railroad waybill data. Total net shipments (receipts) were determined by subtracting consumption from production. Net truck shipments (receipts) were determined by subtracting net waterborne and rail shipments (receipts) from total net shipments (receipts).

a. BEA segments defined as counties which are ultimate origins and destinations of waterborne movements.

b. Primary Study Area shipments equal inbound, outbound and local shipments for the PSAs as a unit and do not equal the sum of shipments reported for each of the BEAs or BEA segments.

c. Includes 9.0 thousand tons shipped via BEA 68.

Source: Estimated production and consumption from Tables 3 and 5. Water and rail shipments (receipts) compiled by RRNA from Waterborne Commerce by Port Equivalents, revised 1976, and ICC Railroad Waybill Sample, 1976, supplied by the U.S. Army Corps of Engineers.

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commodities. The primary reason is that barge rates are substantially below rail rates, and origin and receipt points are usually on or within the proximity of a river.

The Group VIII (Iron Ore, Steel and Iron) Report indicates that slag producers (i.e., iron and steel plants) are mostly located on the riverbanks in BEAs 66 (Pittsburgh), 62 (Cincinnati) and 52 (Huntington). Barges would provide the most economical transport mode for this high weight to value commodity. Rail not only costs more per ton mile, but there is often no railroad running parallel to the waterway. Rail transportation would therefore usually involve extra costs of transshipment. Petroleum and coal products transportation share common characteristics with slag. Major producers of these commodities are in Ashland (in BEA 52) and BEA 55 (Evansville) for petroleum products, and in BEA 66 (Pittsburgh), BEA 52 (Huntington) and BEA 62 (Cincinnati) for coal products. These are all within a few miles of the Ohio River. Waterway improvement materials have been supplied by two producers in BEA 115 (Paducah), one located near the Tennessee River and the other near the Cumberland River. The locations of destination points are on the rivers which provide barge transportation -- an advantage over competing modes.

B-2. Barge versus Truck

Truck rates are substantially higher than barge rates for long-distance shipments. However, since truck transportation does not require transshipments, it is usually more economical than barge for movements of less than 50 to 70 miles. This common rule varies, however, according to commodities within the group and the locations of producers and consumers. Most movements of slag and petroleum and coal products are within the vicinity of the producers. This is the major factor which causes a large percentage share of the movements of these commodities to depend on shipments by truck.

C. Forecasting Procedures and Assumptions

Generally, the projections of waterborne movements assume that the future transportation of the commodities analyzed in this report will conform to historical links and modal split (Table 8).

Forecasts of future shipments and receipts of Group XV products are based primarily on projections of production and consumption of these commodities. Initial projections of waterborne

Table 8. Ohio River Basin: Production, Consumption and Shipments by Mode of Transportation of Others, Nec., Estimated 1976 and Projected 1980-2040, Selected Years

(Thousands of tons unless otherwise specified)

	Estimated 1976	Projected					Average annual percentage change	
		1980	1990	2000	2020	2040	1976-2000	2000-2040
Production[a]	15,273.5	17,061.7	15,425.4	16,253.8	18,661.7	20,685.4	0.3	0.6
Consumption[a]	5,373.9	5,922.4	6,051.5	6,557.3	7,615.9	8,169.5	0.8	0.6
Net shipments (receipts)	9,899.6	11,139.3	9,373.9	9,696.5	11,045.8	12,515.9	(0.1)	0.6
Net waterborne	3,407.1	3,361.6	3,479.3	3,376.7	3,120.7	2,985.8	b	(0.3)
Net rail	231.6	284.0	290.8	313.1	377.2	456.0	1.3	0.9
Net truck	6,260.9	7,493.7	5,603.8	6,006.7	7,547.9	9,074.1	(0.2)	1.0
Gross waterborne shipments:								
Outbound	3,534.5	3,742.2	3,757.7	3,746.2	3,718.2	3,684.2	0.2	b
Inbound	127.4	380.6	278.4	369.5	597.5	698.4	4.5	1.6
Local	657.5	688.9	677.6	685.4	722.9	760.1	0.2	0.3
Total	4,319.4	4,811.7	4,713.7	4,801.1	5,038.6	5,142.7	0.4	0.2

Note: Projected net shipments (receipts) determined by subtracting projected consumption from projected production. Initial projections of waterborne shipments and receipts were based on preliminary information provided by the Corps of Engineers. Projected modal split for individual BEAs would remain constant in the future except when data, analyses and conversations with industrial authorities indicated otherwise. Gross waterborne shipments for each BEA (inbound, outbound, local) were projected by assuming that the relationship between gross and net waterborne shipments in 1976 would remain constant in the future except when data analyses and conversations with industrial authorities indicated otherwise. As more complete information regarding 1976 waterborne traffic was made available, BEA-to-BEA projections were revised, and projected to increase/decrease at the same rates as projected earlier. Net truck and net rail shipments by BEA and BEA segment were assumed to have the same relationship to one another that existed in 1976.

a. Includes petroleum and coal products, nec.; slags; and waterway improvement materials only.

b. Less than ± 0.05 percent.

Source: Tables 4, 6 and 7; Waterborne Commerce by Port Equivalents 1969-76, supplied by the U.S. Army Corps of Engineers.

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commerce were developed using preliminary information provided by the Corps of Engineers. These initial projections were based on the 1976 modal split by BEA and BEA segment. Projections of total net shipments/receipts of each of the seven BEA segments were made by comparing the projected future production and consumption of Group XV products of these BEAs. The total net shipments/receipts were then distributed to rail, truck and water based on existing patterns. Gross water movements were assumed to maintain the same relationship to net water movements in the future as in the past.

These projections of waterborne shipments and receipts were distributed among BEA-to-BEA links using historical distribution of shipments data among BEA receivers. These projections were adjusted for projected changes in BEA shipments and receipts from specific knowledge acquired by commodity specialists during the course of this study.

As more complete information was made available by the Corps of Engineers, the initial projections of BEA-to-BEA waterborne traffic were adjusted.[1]

A shortcoming of the assumption that 1976 patterns will prevail in the future is that it does not account for possible dramatic shifts in the movements of waterway improvement materials. Due to government bidding procedures, there is no assurance that the rip-rap limestone used in the construction and repair of waterways will be supplied by the same producers in the future as in the past. Should new producers win future bids, there could be a substantial change in outbound and local movements. However, this shortcoming is unavoidable.

D. Probable Future Modal Split

Based on the assumption that there will be no change in the relative prices of transport modes, and based on the conjecture that relative transport time will not change substantially, the future modal split will depend on the production and consumption of individual BEAs and new transshipment points.

The production of petroleum products in the PSAs is expected to grow at a rate considerably below that of consumption in the future. More inbound shipments will be required from the Gulf Coast. These will likely be transported by barges. In fact, a

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1. A description of the manner in which the initial projections were adjusted is contained in the Methodology Report.

change in modal split has taken place since 1978, where some petroleum products have been shipped to BEA 115 (Paducah) for distribution to the surrounding areas.

Generally, however, the long-run consumption of Group XV will follow the trend production. There will likely be no pronounced shift in modal split.

E. Probable Future Waterway Traffic Flows

BEA-to-BEA waterborne traffic projections are presented in Table 9. Growth indices derived from the traffic projections are presented in Table 10.

The gross ORS waterborne movements of others, nec., are projected to increase by approximately 800 thousand tons from 1976 to 2040. Most of the increase is attributed to the inbound shipment of miscellaneous petroleum products. Outbound shipments are projected to increase from 3,534.5 thousand tons in 1976 to a peak level of 3,757.7 thousand million tons in 1990. The reduced production of miscellaneous petroleum products in the PSAs will cause a decrease in outbound shipments of Group XV commodities in the subsequent decades.

Table 9. Ohio River System: BEA-to-BEA Waterborne Traffic of Others, Nec., Actual 1976 and Projected 1980-2040, Selected Years

ORIGIN BEA	DESTINATION BEA	COMMODITY GROUP	HUNDREDS OF TONS					
			1976	1980	1990	2000	2020	2040
047	141	15	11	11	12	13	14	14
049	091	15	111	116	122	118	127	146
049	115	15	11	13	14	13	13	13
049	138	15	89	99	120	113	112	102
052	052	15	33	47	49	53	64	71
052	066	15	78	90	103	118	155	178
052	114	15	45	52	48	57	75	103
054	062	15	11	8	11	10	9	5
055	064	15	30	27	92	84	35	26
055	077	15	89	100	113	103	92	73
062	066	15	420	470	273	315	480	601
064	052	15	240	263	285	279	263	235
066	046	15	40	42	43	43	42	41
066	062	15	20	20	18	19	27	45
066	064	15	671	562	503	560	715	846
066	066	15	20	21	26	27	33	37
066	114	15	11	12	9	9	12	15
066	115	15	21	62	53	44	44	39
066	138	15	32	36	0	0	0	0
068	115	15	90	99	107	105	99	88
114	055	15	234	266	285	311	359	354
115	038	15	56	59	61	60	59	58
115	046	15	3795	3981	3624	3681	3818	4000
115	055	15	67	47	48	38	30	29
115	064	15	90	95	96	96	97	100
115	066	15	10	11	16	16	16	15
115	115	15	4763	5054	5082	5077	5149	5273
115	132	15	4440	4711	4809	4777	4693	4587
115	133	15	4318	4564	4564	4555	4543	4543
115	134	15	2003	2115	2115	2113	2109	2107
115	135	15	434	459	459	458	457	457
115	137	15	130	138	138	138	135	135
115	138	15	15311	16245	16658	16551	16230	15801
115	140	15	67	70	70	70	70	70
115	915	15	4363	4612	4612	4603	4594	4590
117	047	15	22	23	23	26	27	28
119	115	15	22	33	33	33	32	32
137	055	15	11	22	24	31	42	42
138	049	15	378	395	412	445	484	495
138	052	15	11	60	47	76	88	100
138	054	15	11	11	11	12	14	14
138	055	15	10	18	18	21	25	23
138	062	15	56	352	187	211	453	533
138	064	15	89	244	45	115	322	262
138	115	15	0	718	505	781	1441	2385
140	066	15	67	76	76	82	99	108
141	052	15	352	553	365	533	989	1748
141	066	15	11	35	38	53	91	125
141	115	15	0	1090	715	965	1509	2435
		TOTAL	43194	48117	47137	48011	50756	51427

Note: BEA 915 refers to counties of BEA 115 which are destinations of waterborne movements shipped to points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

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Table 10. Ohio River System: Growth Rates of Others, Nec., Waterborne Commerce, BEA to BEA, Projected 1976-2040, Selected Years

BEA Pair[a]	Group No.	Index Value[b]	Year[c] 1976	1980	1990	2000	2020	2040
047141	15	11	1000	1000	1067	1200	1267	1267
049091	15	111	1000	1043	1096	1061	1148	1313
049115	15	11	1000	1214	1265	1214	1214	1214
049138	15	89	1000	1115	1346	1269	1256	1141
052052	15	33	1000	1417	1483	1600	1933	2150
052066	15	78	1000	1160	1315	1513	1987	2277
052114	15	45	1000	1154	1077	1256	1667	2282
054062	15	11	1000	728	1000	909	818	455
055064	15	30	1000	910	3069	2799	1160	854
055077	15	89	1000	1121	1266	1161	1032	823
062066	15	420	1000	1120	649	749	1144	1430
064052	15	240	1000	1096	1186	1163	1097	979
066046	15	40	1000	1061	1083	1076	1057	1033
066062	15	20	1000	1000	909	955	1364	2273
066064	15	671	1000	837	750	834	1066	1261
066066	15	20	1000	1063	1281	1344	1656	1844
066114	15	11	1000	1071	786	786	1071	1357
066115	15	21	1000	2941	2504	2109	2076	1857
066138	15	32	1000	1130	0	0	0	0
068115	15	90	1000	1096	1186	1163	1097	979
114055	15	234	1000	1136	1216	1329	1535	1512
115038	15	56	1000	1061	1083	1076	1057	1033
115046	15	3795	1000	1049	955	970	1006	1054
115055	15	67	1000	705	721	574	443	426
115064	15	90	1000	1061	1067	1066	1081	1107
115066	15	10	1000	1051	1608	1568	1563	1517
115115	15	4763	1000	1061	1067	1066	1081	1107
115132	15	4440	1000	1061	1083	1076	1057	1033
115133	15	4318	1000	1057	1057	1055	1052	1052
115134	15	2003	1000	1056	1056	1055	1053	1052
115135	15	434	1000	1057	1058	1055	1053	1052
115137	15	130	1000	1063	1063	1063	1042	1042
115138	15	15311	1000	1061	1088	1081	1060	1032
115140	15	67	1000	1050	1050	1050	1050	1050
115915[d]	15	4363	1000	1057	1057	1055	1053	1052
117047	15	22	1000	1040	1040	1160	1240	1280
119115	15	22	1000	1480	1480	1480	1440	1440
137055	15	11	1000	1962	2192	2846	3808	3808
138049	15	378	1000	1046	1090	1176	1280	1309
138052	15	11	1000	5417	4250	6917	8000	9083
138054	15	11	1000	1000	1000	1077	1231	1231
138055	15	10	1000	1750	1750	2125	2500	2250
138062	15	56	1000	6286	3333	3762	8095	9524
138064	15	39	1000	2747	506	1291	3620	2949
138115	15	718	0	1000	703	1088	2007	3322
140066	15	67	1000	1133	1133	1217	1483	1617
141052	15	352	1000	1570	1036	1515	2811	4967
141066	15	11	1000	3143	3429	4857	8286	11357
141115	15	1000	0	1000	715	965	1509	735

a. The first three digits indicate the BEA of origin; the last three digits indicate the BEA of destination.

b. Hundreds of tons.

c. Growth rates are reported such that 1000 equals the index value reported in the third column.

d. BEA 915 refers to counties of BEA 115 which are destinations of waterborne movements shipped to points on the Mississippi River.

Source: Robert R. Nathan Associates, Inc.

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V. APPENDIX

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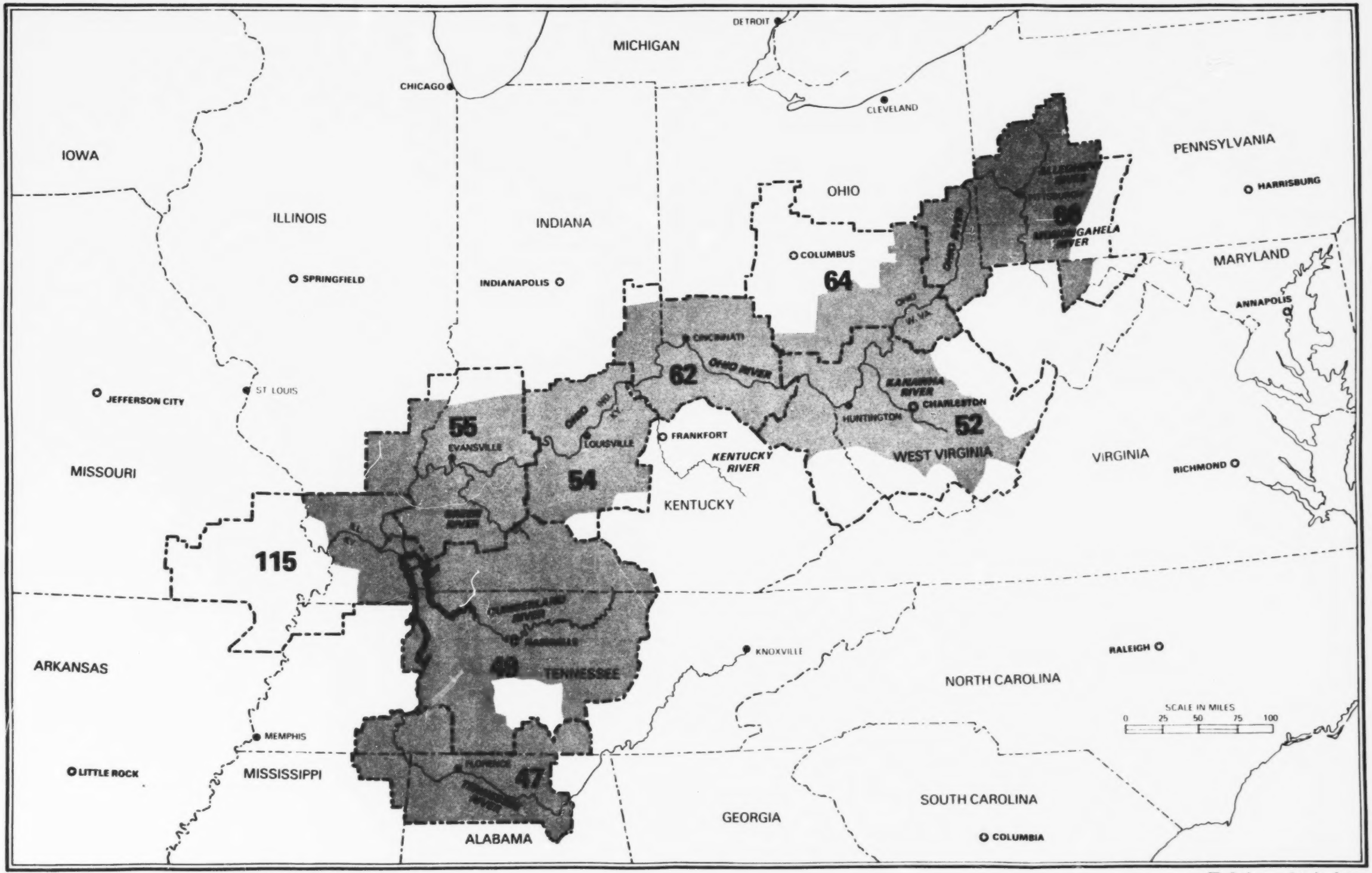
MAP A-1. OHIO RIVER BASIN: PRIMARY STUDY AREAS FOR OTHERS
(BEAs AND BEA SEGMENTS)



SOURCE: Robert R. Nathan Associates, Inc.

Primary Study Areas

Table A-1. Ohio River Basin: Primary Study Areas for Others, Nec. (BEAs and BEA segments)

BEA 47: Huntsville, AL
Colbert, AL
Franklin, AL
Lauderdale, AL
Lawrence, AL
Limestone, AL
Madison, AL
Marshall, AL
Morgan, AL
Alcorn, MS
Tishomingo, MA
Franklin, TN
Hardin, TN
Lincoln, TN
McNairy, TN
Wayne, TN

BEA 49 (segment): Nashville, TN
Allen, KY
Barren, KY
Butler, KY
Christian, KY
Clinton, KY
Cumberland, KY
Edmonson, KY
Logan, KY
Metcalfe, KY
Monroe, KY
Simpson, KY
Todd, KY
Trigg, KY
Warren, KY
Benton, TN
Cannon, TN
Cheatham, TN
Clay, TN
Coffee, TN
Davidson, TN
DeKalb, TN
Dickson, TN
Giles, TN
Hickman, TN
Houston, TN
Humphreys, TN
Jackson, TN
Lawrence, TN
Lewis, TN
Macon, TN
Maury, TN
Montgomery, TN
Overton, TN
Perry, TN
Pickett. TN
Putnam, TN
Robertson, TN
Rutherford, TN
Smith, TN
Stewart, TN
Sumner, TN
Trousdale, TN
Van Buren, TN
Warren, TN
White, TN
Williamson, TN
Wilson, TN

BEA 52 (segment): Huntington, WV
Boyd, KY
Carter, KY
Elliot, KY
Greenup, KY
Lawrence, KY
Rowan, KY
Gallia, OH
Lawrence, OH
Meigs, OH
Scioto, OH
Boone, WV
Cabell, WV
Clay, WV
Fayette, WV
Greenbrier, WV
Jackson, WV
Kanawha, WV
Lincoln, WV
Mason, WV
Nicholas, WV
Putnam, WV
Raleigh, WV
Roane, WV
Sumners, WV
Wayne, WV

(Continued)

Table A-1. (Continued)

BEA 54 (segment): Louisville, KY
- Clark, IN
- Crawford, IN
- Floyd, IN
- Harrison, IN
- Jefferson, IN
- Orange, IN
- Scott, IN
- Washington, IN
- Breckenridge, KY
- Bullitt, KY
- Grayson, KY
- Hardin, KY
- Henry, KY
- Jefferson, KY
- Meade, KY
- Nelson, KY
- Oldham, KY
- Shelby, KY
- Spencer, KY
- Trimble, KY
- Washington, KY

BEA 55 (segment): Evansville, IN
- Caldwell, KY
- Crittenden, KY
- Daviess, KY
- Hancock, KY
- Henderson, KY
- Hopkins, KY
- McLean, KY
- Muhlenberg, KY
- Ohio, KY
- Union, KY
- Webster, KY
- Edwards, IL
- Gallatin, IL
- Hamilton, IL
- Saline, IL
- Wabash, IL
- White, IL
- Dubois, IN
- Gibson, IN
- Perry, IN
- Pike, IN
- Posey, IN
- Spencer, IN
- Vanderburgh, IN
- Warrick, IN

BEA 62 (segment): Cincinnati, OH
- Dearborn, IN
- Franklin, IN
- Ohio, IN
- Ripley, IN
- Switzerland, IN
- Boone, KY
- Bracken, KY
- Campbell, KY
- Carroll, KY
- Fleming, KY
- Gallatin, KY
- Grant, KY
- Kenton, KY
- Lewis, KY
- Mason, KY
- Owen, KY
- Pendleton, KY
- Robertson, KY
- Adams, OH
- Butler, OH
- Brown, OH
- Clermont, OH
- Clinton, OH
- Hamilton, OH
- Highland, OH
- Warren, OH

BEA 64 (segment): Columbus, OH
- Athens, OH
- Guernsey, OH
- Hocking, OH
- Jackson, OH
- Morgan, OH
- Noble, OH
- Pike, OH
- Vinton, OH
- Washington, OH
- Pleasants, WV
- Ritchie, WV
- Wirt, WV
- Wood, WV

BEA 66 (segment): Pittsburgh, PA
- Garrett, MD
- Belmont, OH
- Harrison, OH
- Jefferson, OH
- Monroe, OH
- Allegheny, PA

(Continued)

Table A-1. (Continued)

Armstrong, PA
Beaver, PA
Butler, PA
Clarion, PA
Fayette, PA
Greene, PA
Indiana, PA
Washington, PA
Westmoreland, PA
Brooke, WV
Hancock, WV
Marshall, WV
Ohio, WV
Tyler, WV
Wetzel, WV

BEA 115 (segment): Paducah, KY
Hardin, IL
Johnson, IL
Massac, IL
Pope, IL
Pulaski, IL
Union, IL
Ballard, KY
Calloway, KY
Graves, KY
Livingston, KY
Lyon, KY
Marshall, KY
McCracken, KY

Source: Robert R. Nathan Associates, Inc.

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B. Industrial Shippers and Receivers

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Consolidated Coal Company, Osage, West Virginia and Marshall County, West Virginia.

Ford Coal Company, Coalburg, West Virginia.

Gulf Oil Company, Transport Department, Pittsburgh, Pennsylvania.

Island Creek Coal Company, Hamilton, Kentucky.

Marquette Cement Company, Neville Island, Pennsylvania.

National Steel Company, Transport Department, Pittsburgh, Pennsylvania.

Reed Crushed Stone Company, Near Benton, Kentucky.

Wheeling Pittsburgh Steel Corporation, Pittsburgh, Pennsylvania.

C. Associations, Government Agencies, and Educational Institutions

American Trucking Association, Inc., Washington, D.C.

Kentucky Center for Energy Research, Lexington, Kentucky.

National Crushed Stone Association, Washington, D.C.

Oak Ridge National Laboratories, Energy Division, Oak Ridge, Tennessee.

Office of the Governor of West Virginia, Department of Economic Development, Community Development, Office of Program Supports, Charlestown, West Virginia.

Ohio Department of Commerce and Community Development, Office of Research, Columbus, Ohio.

Ohio Department of Energy, Columbus, Ohio.

Ohio Department of Transportation, Division of Planning and Design, Columbus, Ohio.

Port Authority of Greater Pittsburgh, Pittsburgh, Pennsylvania.

Regional Industrial Development Corporation of Southwestern Pennsylvania, Pittsburgh, Pennsylvania.

Tennessee Valley Authority, Navigation and Regional Economics, Knoxville, Tennessee.

U.S. Army Corps of Engineers, Construction and Operation Division, Washington, D.C.

University of Kentucky, Department of Economics, Pittsburgh, Pennsylvania.

University of Pittsburgh, Department of Economics, Pittsburgh, Pennsylvania.

University of Tennessee, College of Business Administration, Knoxville, Tennessee.

University of West Virginia, Department of Mineral Economics, Morgantown, West Virginia.

D. Terminals, Barges and Towing Companies and Railways

Louisville and Nashville Railroad Company, Louisville, Kentucky.

Ohio River Company, Cincinnati, Ohio and Huntington, West Virginia.

River Transport Company, Cincinnati, Ohio.

Riverway Louisville Terminal Company, Louisville, Kentucky.

Yankeetown Dock Corporation, Newburgh, Indiana.